Plastic Forming Fabrics Give Significant Advantages Compared with Bronze Wires

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There has been a very strong development of plastic forming fabrics in the last years and the interest from the paper industry has been steadily increasing because considerable reductions in manufacturing costs are possible for those paper mills who succeed to replace bronze wires with plastic forming fabrics.

Because the policy of Nordiskafilt is to be a leader in dewatering and drying of paper and cellulose, our company has during the last ten years directed a substantial share of its research and development activities into plastic forming fabrics. This has also given results, and the coming fast switchover from bronze wires to plastic forming fabrics can be met with many good qualities.

At our Norwegian subsidiary, NORDISKA FILT og Virer A/S in Oslo, a completely new mill fully specialized in manufacturing plastic forming wires has been erected. This mill has a large manufacturing capacity, which quickly can be increased. Looms, stretching tables and other machines are the most modern that can be achieved today, and plastic forming fabrics even for the most modern paper machines can be manufactured here.

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Which are now the functions that a forming fabric must fulfill and what demands can be formulated therefrom ?

The main function of the forming fabric is to support the sheet formation, and in cylinder mould machines the fabric has only this task.

On fourdrinier machines the forming fabric must also transfer sufficient power from the driven roll (s) so that the resistance from the breaking elements is overcome. The fabric therefore also must have high strength and stability on these machines. Furthermore–like all good machine clothing–the forming fabric must be easy to handle and have good runability. Finally it must run so long that the cost per ton paper produced becomes low.

To support the sheet formation, the bronze wires fuction well. Through a manufacturing technique developed through many years, the present bronze wires can be manufactured very even and with good drainage properties. Bronze wires also function well for transmitting power, mainly because they get good running tension at low elongation and because of a very high stability in the cross machine direction.

The poorest properties of the bronze wire are its low fatigue resistance and its permanent deformation already at moderate elongations. The bronze wire must therefore be made very thin, normally 0.5 mm, so that the bendings around the rolls do not fatigue the material. Still edge cracks and seam failures often happen when the fatigue resistance is exceeded.

Because the bronze wires are permanently deformed even at moderate elongations, ridges and dents are difficult to avoid at installation or during service. These spots wear rapidly, which reduces the service life.

The low fatigue resistance and tendency for permanent deformation of the bronze wires therefore should be eliminated while their good sheet forming support and stability should be maintained. Obviously a material with greater resistance against the mechanical and chemical wear is desired. The modern plastic materials have those properties. Their fatigue resistance are about a hundred times superior to phosphor bronze and even at high elongation they deform very little, which means that even at high running tensions the plastic forming fabric is almost completely elastic.

The plastic material which is most suitable for forming fabrics is polyester, which is supplied both as multifilament and monofilament. Already at the end of the 1950's polyester filaments in suitable dimensions were available and trials were made to weave forming fabric thereof, but in general, problems arose. Such a forming fabric elongated several percents before it reached the running tension that the paper machine required. As the stretching facilities of the wire sections are dimensioned for bronze wires, the plastic forming fabrics could not be used without increasing the stretching length.

The problem especially on large paper machines was ridging because the cross machine stability of plastic forming fabric was much lower than that of bronze wires.

Several attempts to overcome these problems were made along several lines. It was tried to weave endless or to flat weave and join. Multifilament yarns and monofilament yarns were tried and single layer designs as well as double layer designs were used.

Two completely different solutions were reached rather quickly, namely the, endless woven multifilament fabric and the flat woven joined monofilament fabric. The first of these was superior in machine direction stability and dewatering, while the second had the best cross machine stability.

Like the bronze wires, our first plastic forming fabrics were single layer, 3-shaft designs; MONOTEX.

The MONOTEX, receiving an advanced heat-setting treatment has significantly better machine direction stability than most competing products.

Now, for a bronze wire it is a necessity that the thickness is kept at a minimum in order to exceed the fatigue resistance. Plastic forming fabrics, however, can be made several millimeters thick, and as Nordiskafilt has a long experience with double layer dryer screens and press fabrics, we have during the last five years worked intensively on developing double layer forming fabrics.

What can be gained by making a double layer forming fabric? Most important is the improved stability, but better drainage and reduced sheet adhesion are possible. The stability increase with a double layer fabric is very pronounced.

In such a weave it is possible to incorporate so much material both in the machine and the cross machine direction that as good stability or even better can be achieved than that of the bronze wire. Nordiskafilt also succeeded in developing and manufacturing double layer forming fabrics and are now marketing a flat woven joined design under the trade name DUOTEX which has given very good results.

How do the properties of single and double layer forming fabrics compare with those of bronze wires? The load/elongation properties in the machine direction are of the greatest interest. Figure 1 shows the elongation as a function of the wire tension for a bronze wire, a DUOTEX and a MONOTEX. As the average running tension for an average size paper machine is around 5 kp/cm, it can then be calculated how much stretching facilities the wire section needs in order to run these wires. If there is an average wire tension of 5 kp/cm the bronze wire will elongate only 0.25%, while DUOTEX elongates 0.50% and MONOTEX 1%. DUOTEX therefore can be installed on the majority of the existing wire sections, while MONOTEX requires greater stretching facilities than what is normally found. (In most cases, however, this can be compensated for by making MONOTEX somewhat shorter than the bronze wire.)

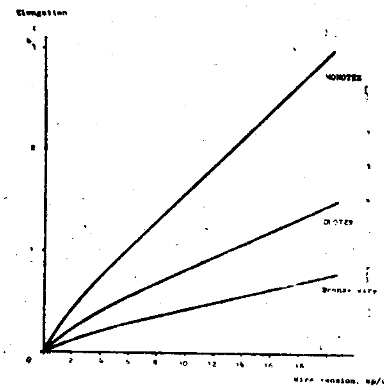

Fig. 1

When looking at the plastic forming fabric from other suppliers it can be stated that most of the flat woven joined fabrics elongate substantially more than MONOTEX while endless woven wires can have almost as good elongation properties as DUOTEX. Nordiskafilt has also experimentally manufactured endless double layer fabrics, which in fact can be made with less elongation than bronze wires.

Another interesting property is the cross machine stability. The bronze wire has very good such properties and with high tension it does not contract in width. Contraction is the reduction in wire width, when the wire length increases under tension. DUOTEX has as good properties as the bronze wire, namely very high stability in the cross machine direction and neglectable contraction even at high tension.

The cross machine stabitity of MONOTEX is only 1/4 of that of the bronze wire and the contraction is around 0.4% width reduction for 1% elongation. Figure 2 shows how

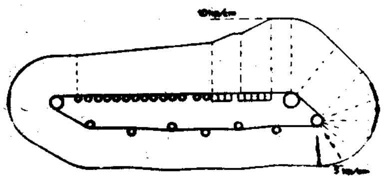

Fig. 2

the wire tension varies around the wire run. For each revolution the tension increases from its minimum after the forward drive roll to its maximum before the couch, whereafter it drops back to the minimum again. For bronze wires and DUOTEX the wire width is unchanged, because contraction is nil, but for MONOTFX the wire width has its minimum before the couch and its maximum after the forward drive roll. This variation is around 1/4%, which equals 1 cm at a 4 m wire width. The width increase after the forward drive roll can easily be seen as machine directional waves in the fabric. If the width increases too fast the wire can easily ridge, for which reason on wide machines it is recommendable to control the width increase with bowed rolls or bars. This is normally needed above 4 metre wire width.

When comparing the contractions of other suppliers' fabrics it can be stated that for most flat woven monofilament fabrics the contraction is greater than for MONOTEX, because fabrics which elongate more under the running tension also contract more. Endless multifilament wires are very sensitive and require bowed rolls even at moderate machine widths while endless monofilament wires can be manufactured completely without contraction, which means that they can be run without bowed rolls like bronze wires and DUOTEX.

The wear resistance greatly determines the service life of plastic forming fabrics. Laboratory investigations of the polyester material do not show substantially better values than for phosphor bronze, especially in the presence of abrasive agents. Practical experience, however, shows that in most cases plastic forming fabrics run several times the life time of bronze wires. This can probably be explained by the bronze wires being worn by the combined effect of corrosion and mechanical wear, and that the wires in most cases are removed prematurely because of local wear spots or edge cracks. With strongly abrasive stocks it has been reported, however, that plastic forming fabrics are worn out as fast or even faster than bronze wires, which verifies that the wear resistance of the plastic material is not particularly superior to phosphor bronze. However, also on those machines it should be possible to get improved service life with plastic forming fabrics if the wires are manufactured in a double layer design, whereby the wear can be distributed on a higher number of thicker filaments than what is possible with a bronze wire.

Drainage properties of wires are difficult to measure. At similar wire designs measuring air or water permeability can give some indications but when comparing a single and a double layer design drainage test with real stocks and realistic drainage times must be conducted. Table 1 shows the results from a trial with a

Table 1

	Kraft	News-print	Fine paper
Bronze wires	0.45–0.51	1.13–1.88	0.80
Monotex	0.46–0 50	1.65–1 73	0 83–0 90
Duotex	0.47–0 53	0.99–1.16	0.80–0.87

dynamic drainage tester at the Swedish Wood Research Centre in Stockholm. The drainage time was here recorded when forming a 100g/m² sheet of kraft, newsprint and fine paper stock on bronze wires and MONOTEX and DUOTEX.

Hardly no difference was found with the kraft stock. With newsprint DUOTEX is much superior, while with fine paper stock the broze wires drained somewhat faster than the plastic forming fabrics. These results have been verified on experimental and real paper machines. It can be concluded that MONOTEX normally drains equal to or somewhat slower than bronze wires, while DUOTEX drains considerably faster.

The adhesion between paper sheet and wire is even more difficult to measure. The problems here seem to relate to fibres getting entrenched in the wire mesh, and this is dependent on how the sheet is formed on the drainage elements. The experience so far is that plastic forming fabrics often have a tendency for higher sheet adhesion, which can be critical on tissue and fluting grades of paper. It seems logical that the DUOTEX design would enable plastic forming fabrics to adhere less than bronze wires, because there are no vertical openings in the surface of DUOTEX in which the fibres can get entrenched.

Finally a few words about seams. The weakest part of the bronze wire has always been the seam, and still often marking and breaks appear there. Plastic forming fabrics are supplied with spliced seams and for both MONOTEX and DUOTEX completely marking-free seams have been developed. The seams have the same openness as the rest of the fabric and very good strength. Low marking pin seams are of special interest for coarse papers. On a single layer forming fabric a pin seam always is thicker than the fabric, which causes more wear in the seam, but with DUOTEX it is possible to make a pin seam which is thinner than the rest of the fabric, and such wires have been run with very good results. If a forming fabric can be supplied open, and be joined on the machine, it is of course possible to simplify the wire changing procedure considerably and to shorten the wire changing time. DUOTEX with pin seam has already run successfully on board, but it is hoped that this seam also will be possible to use on fluting and liner.

In conclusion it can be stated that the single-layer monofilament fabric MONOTEX has very good properties compared both with bronze wires and plastic forming fabrics from other suppliers. Because of its relatively low cross machine stability it requires some machine modifications on big paper machines.

DUOTEX has most of the advantages of the bronze wires. Our only initial problem to consider has been the marking on paper grades finer than 60 g/m^2, however, we are now eliminating that risk by slightly modifying the weave pattern. Since DUOTEX is a young product on the market we have still relatively few commercial installations, but, the results are very promising.

Let us take a few examples from the reference list: DUOTEX type 6080/0, No 179094, 6.9 m wide, ran 179 days on a liner machine running 500–550 m/min, which should be compared to only 8–12 days with phosphor bronze wires.

DUOTEX type 6077/4, No 125115, 7.34 m wide, removed because of accident after 52 days from a sack paper machine running 580 m/min. Phosphor bronze wire generally ran only 6 days and single-layer plastic wires cannot be used at all because of the heavy load being about 1000 KW (135 KW/metre width).

DUOTEX type 6078/0, No 124462, 7.00 m wide, has been running for 80 days at the time of writing this, on a newsprint machine running 660 m/min which must be considered as an extremely good result.

DUOTEX type 6078/0, No 126352, 5.61 m wide, has been running for 4 months at the time of writing this on a greaseproof machine in Norway, speed 110–170 m/min. Drainage is said to be excellent.